Effectiveness of Therapeutic Positioning on Preterm Infants in the NICU: A Rapid Systematic Review

Alisyn Larkin, OTS; Claire Lindenmayer, OTS; Sarah Nickerson, OTS; Mary Parks, OTS; Shelby Richardson, OTS; Grace Withrow, OTS

Key Words
- Evidence-Based Practice
- Preterm Infants
- Therapeutic Positioning
- Occupational Therapy

Abstract

In this systematic review, we examine the potential positive impacts that positioning techniques and devices can have on physiological, neurological, and developmental outcomes in preterm infants in the Neonatal Intensive Care Unit (NICU). This paper describes the reasoning behind the beneficial effects of positioning strategies and how they can lead to healthy development. Due to the stress-inducing, high intensity environment of the NICU, non-invasive interventions that promote healthy physiological and neurological responses are undeniably necessary. Positioning techniques such as skin-to-skin contact, the use of different devices, and varying positions all have evidence supporting the effectiveness of positioning on developmental responses and outcomes. Occupational therapy (OT) practitioners are positioning professionals, making their role in the NICU very valuable.

Focused Clinical Question

The purpose of this rapid systematic review is to critically appraise the evidence for effectiveness of therapeutic positioning in improving physiological, developmental, and neurological factors in preterm infants in the Neonatal Intensive Care Unit (NICU) compared to standard positioning care.

What is the evidence for the effectiveness of therapeutic positioning in improving physiological, developmental, and neurological factors as opposed to standard patient positioning in preterm infants in the neonatal intensive care unit?

Statement of Problem

This rapid systematic review provides appraisal of evidence for a multitude of positioning strategies and devices which can be used in occupational therapy (OT) practice in the NICU. Such information is significant for clinical OT practice because it is important for practitioners to have knowledge of interventions and research which support physiological, psychological, and social-emotional development of their clients, and the evidence appraised here indicates that therapeutic positioning has potential to impact all of the above. For this reason, education on developmental positioning would be a valuable addition during training of new practitioners, that they may, in turn, bring information and clinical implementation to their colleagues in future fieldwork and job placements.

This is currently a limited area of practice and more research is needed to provide further evidence supporting different positioning techniques in the NICU. Because of the need for more observation of these techniques in clinical settings, as well as the fact that current evidence supports little increased risk to the infants using these techniques, implications are good for implementation of positioning programs for patients, parents, and staff of local NICUs.

Premature birth is, unfortunately, a common occurrence in our world today, and techniques to improve outcomes for these preterm infants are increasingly needed by our society. This is yet another reason why implementation of techniques such as therapeutic positioning which can lead to improved occupational performance outcomes for preterm infants is very needed by our society.

Background

The Neonatal Intensive Care Unit (NICU) is a high stress setting with several loud environmental factors including sound and light. The NICU can be an overwhelming setting for babies and guardians, which can create challenges to typical development for premature infants.

Most babies admitted to the NICU are preterm, meaning they are born before 37 weeks of pregnancy or have low birth weight of less than 5.5 pounds or other health conditions that need specialized care. In the United States, nearly half a million babies are born preterm and many of them also have low birth weights (Stanford Children's Health, 2019).

Long-term implications of prematurity include differences in brain development, cognitive abilities, educational achievement, and social and emotional behavior (Vittner, 2018). Much of these risks can be attributed to the stressful environment of the NICU and the stationary nature of an incubator. The environment of the NICU makes self-regulation extremely difficult for premature infants. Without self-regulation of their autonomic nervous system, these babies demonstrate disorganized behavior and unrelieved pain responses that increase stress and therefore decrease their ability to develop typically (Liaw, 2012). Several interventions discussed in this study, such as skin-to-skin contact (SSC) or Kangaroo Care (KC), various positioning methods (variations of supine, lateral, and prone) and devices, and parental involvement all are aimed to increase autonomic regulation and as a result encourage healthy brain and motor development. The stationary nature of the NICU also has the potential to inhibit healthy development due to the frequent head flattening (McCarty, 2018) and lack of human touch that often comes with extended periods of time inside an incubator. Several interventions, explained by the studies included in this review, work to prevent or correct head flattening around 32-35 weeks gestational age. These flattening conditions are paramount to correct due to their potential to delay reaching skills, cause tightened spinal extensors and scapular retractors, and produce asymmetrical motor development (McCarty et al., 2018). Midliner positioning tools and cranial cups can help prevent these specific issues, and methods such as skin-to-skin contact and parent handling help to relieve the issues associated with lack of human contact.

The effects of positioning on preterm infants is important for proper development and impacts participation long term. Preterm infants have weak muscles creating difficulties facilitating movement against gravity and having adverse effects on movement patterns (Positioning your Premature Baby, 2016). Improper positioning could affect upper extremity and lower extremity movement, affecting walking, crawling, sitting and balance later on. The effect of gravity in upper extremities, when infants are positioned in supine creates difficulty for them to bring arms to midline. For lower extremities, improper positioning could cause hip dislocations if their legs are positioned out to the side of their body for long periods of time (Positioning your Premature Baby, 2016).

Throughout this systematic review, there were many types of intervention approaches used based on the study. Kangaroo care (skin-to-skin) is an intervention approach that entails the child being placed on their mother's bare chest for skin to skin contact. In-arms-holding technique is another intervention used in the NICU setting. This technique involves the mother cradling her baby and supporting the child's head and neck with her left arm. Massage therapy within this systematic review entailed a superficial stroking method with use of Tiffany field conventional techniques. Prone positioning refers to the infant being laid on their stomach. Supine positioning refers to the infant being placed on their back. Nesting positioning within this systematic review refers to infants being limited (similar to that in the womb); thus the preterm infant has a surface to touch and continuous resistance that mocks the conditions of the womb--which typically is soothing for the infant. Nesting positioning also maintains the flexion posture, while maintaining intrauterine position and postures. Sheets and towels were used to create the nesting positioning within this systematic review. The Dandle Roo device is a structured blanket that results in the infant being placed into a weight bearing flexed position. Head shaping interventions consisted of midliner positioning to prevent lateral head flattening and cranial cups to correct asymmetrical positional head shapes. Hammocking techniques used within this systematic review referred to preterm infants being placed in a hammock within their incubators. A conformational positioner mattress was used that conforms to the individual infants needs and provides containment. This device was adjustable to the positioning needs of each infant and maintained shape throughout, allowing for the infant to push against the barrier for support.

Facilitating proper breathing is another concern addressed in the NICU with positioning. Due to delayed development of the premature infants, respiratory issues are common. Optimal positioning, in the prone position for the infants lungs to aerate is important for proper development and functioning (Positioning your premature baby, 2016). It is important to keep the breathing pathway open, due to the lack of development of the neck muscles. The effect of gravity tends to pull the infant's head to one side of the body, shortening neck muscles. Narrowing the air passage and creating difficulties with eating and swallowing. (Positioning your premature baby, 2016).

Occupational performance is highly impacted by potential developmental deficits, making typical infantile development relevant to the discipline of occupational therapy. Occupational therapists in the NICU are working to help preterm infants participate in activities such as bonding with caregiver, receiving sanitary care, feeding and exploring the environment and play. Therapists help promote bonding between caregivers and babies as well as developing skills that play a part in achieving future development milestones.

The purpose of this study is to examine the effects of patient positioning as an intervention for preterm infants in the NICU and its implications for occupational therapy practice. This review will help to explain the cause and effect of difficulties faced by preterm infants in the NICU, and various ways in which we can combat, prevent, and resolve these issues within the scope of occupational therapy practice.

Method for Conducting the Evidence-Based Review

The American Journal of Occupational Therapy (AJOT) uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as the protocol for systematic reviews (Moher, 2009).

The study search was conducted by the following students in the IU Doctor of Occupational Therapy program: Alisyn Larkin, Claire Lindenmayer, Sarah Nickerson, Mary Parks, Shelby Richardson, and Grace Withrow.

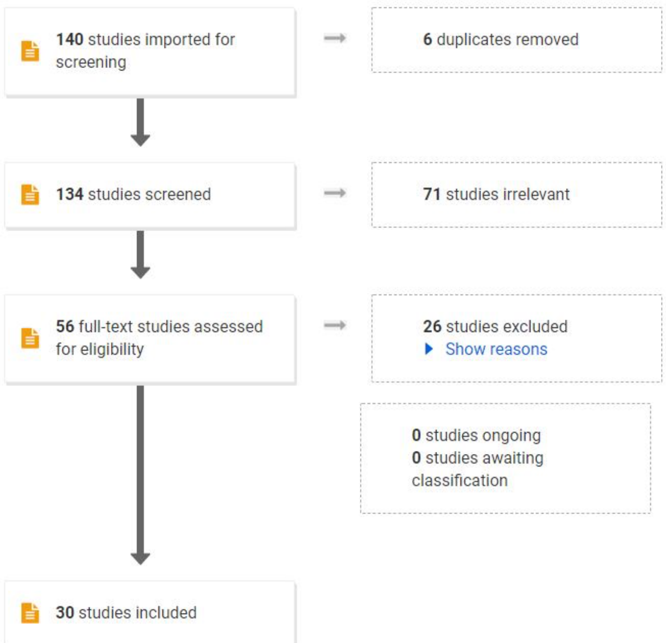
The overall search was based on the PICO of P (Population): Premature infants in the NICU, I (Intervention): Therapeutic positioning, C (Comparison): Traditional positioning, O (Outcomes): Positive health outcomes. The search inclusion criteria included: studies on premature infants, studies in the NICU setting, studies focusing on therapeutic patient positioning, studies with reliable outcome measures, and studies performed in Australia & New Zealand, Canada, United Kingdom & Ireland, USA, Taiwan, Brazil, Netherlands, Norway, Iran, and France. Exclusion criteria included: systematic reviews and meta-analyses. The search of PubMed and CINAHL was performed during the time period of 1/21/2020-1/28/2020.

The search was performed using PubMed and CINAHL. On PubMed, the search MeSH terms were the following: Infant, premature; Patient Positioning; Intensive Care Units, Neonatal Randomized Controlled Trials. On CINAHL, the search heading terms were the following: (premature infants or premature infant or preterm infants or preterm infant or premature baby or preterm baby or neonates); patient positioning; (intensive care units, neonatal or neonatal intensive care unit). A 10 year range of published studies was used for all searches specifically 2009-2019. Additionally, country filters were applied to include studies from Australia & NZ, Canada, UK & Ireland, and USA.

The levels of evidence description used to screen and sort articles was as following: Level I: Randomized controlled trials; Level II: Cohort studies, two-group nonrandomized studies; Level III: Case-controlled studies, one-group non randomized pre/post-test study, cohort studies; Level IV: Observational, case series (OCEBM Levels of Evidence Working Group, 2011).

The studies from PubMed and CINAHL were imported into Covidence to screen studies to be included (Covidence systematic review software, 2020). 140 studies were imported to screen. 6 duplicates were then removed, leaving 134 studies to be screened in Covidence. The Covidence screening process included two steps, a title and abstract screening, and a full text screening. A study had to be approved by two reviewers to move onto the next step of the screening process. 71 of the 134 studies were determined irrelevant based on the title and abstract screening. 56 studies were reviewed under full text screening and then 30 studies were included in the systematic review (see Figure 1).

Figure 1. PRISMA Flow Diagram for studies screened and included



Results

This review includes a total of 30 studies--11 Level I, 10 Level II, 7 Level III, and 2 Level IV (see Table 1 in supplement for details). The findings have been clustered into three themes that represent the types of treatments administered to preterm infants in the NICU in these studies. These treatment themes are Skin-to-Skin Contact (SCC) or Kangaroo Care (KC); Supine, Prone, and Lateral Positioning Variations; and Positioning Devices and Equipment.

Skin-to-Skin Contact/Kangaroo Care

Three Level I studies focused on skin-to-skin contact, also known as kangaroo care. These studies showed that infants who experienced KC had longer periods of deep sleep and quiet-alert states (Bastani, F., Rajai, N., Farsi, Z., & Als, H., 2017) as well as significant changes in heart rate levels (Parsa, P., Karimi, S., Basiri, B., & Roshanaei, G., 2018). Five Level II studies showed that KC increases salivary oxytocin levels for infant-caregiver bonding (Vittner et al., 2018), can help to relieve pain (Cong et al., 2012), and is safe for preterm infants (Kristoffersen, Stoen, Hansen, Wilhelmsen, & Bergseng, 2016). Two Level III studies show that preterm infants that experience SSC have decreased incidence of secondary infection (Casper, Sarapuk & Pavlyshyn, 2018) and display less hypertonia (Reynolds et al., 2013).

Supine, Prone, and Lateral Positioning Variations

There were 4 level I studies reviewed that discussed supine, prone and lateral positioning in the NICU and how it facilitates growth. It was found that prone positioning decreased gastric residual volume in order to increase nutrient absorption (Khatomy, Abdi, Karimi, Aghael, & Brogeni, 2019). Prone positioning led to reduced heart rate and increased oxygen saturation levels (Elsagh A, Lotfi R, Amiri S, Gooya H., 2019).
Prone positioning indicated a decrease in stroke volume (SV), CO, and skin blood flow (SBF) levels and an increase in systemic vascular resistance (SVR) index (Ma, M., Noori, S., Maarek, J. et al., 2015). Infants in facilitated tucking positions had more quiet sleep when used in addition to nonutritive sucking and oral sucrose (Liaw et al., 2013). There were three level II that addressed positioning. It was found that the semi-elevated, side-lying position (ESL) had less variation in HR, oxygen saturation, higher breathing frequency, and longer duration of feeding (Park, Thoyre, Knafl, Hodges, & Nix, 2013). The use of Standard Operating Procedure of positioning may decrease pain and respiratory rate in comparison to traditional positioning (Santos, Viera, Toso, Barreto, & Souza (2017). Therapeutic positioning may have an impact on physiological parameters; specifically, respiratory rate was found to increase in the lateral position and stabilize in semi-prone (Yin, Yuh, Liaw, Chen, & Wang, 2015). There were two level III that addressed the effects of positioning. It was found that lateral and prone positioning can facilitate active sleep (Liaw et al., 2011). Lastly, there was one level IV that found that repositioning and prone positioning reduced abnormal head shape (Danner-Bowman & Cardin, 2015).

Positioning Devices and Equipment

Ten of the included 30 studies examined the impact of therapeutic positioning with the use of positioning devices and equipment. The equipment utilized ranged from specific brand devices such as Dandle Roo devices and VestibuGlide chairs to more generalized equipment such as hammocks, cranial cups, types of mattresses, and even towels. The levels of evidence present in this group were strong overall, with the inclusion of four Level I, two Level II, three Level III, and only one Level IV study. These studies found that positioning devices can help to achieve a large range of positive outcomes, from preventing and correcting head shape deformities (Diertens & Wielenga, 2018; McCarty et al., 2018) to decreasing pain and improving sleep quality (Gemin-Ribas et al., 2019; Comaru & Miura, 2009; Lacina et al., 2015) to even improving respiratory rate and oxygen saturation (Kahraman et al., 2018; Zimmerman & Barlow, 2012) as well as other factors. Studies by Painter et al. (2019) and Madlinger-Lewis et al. (2014) discovered potential for improvements in neurological scores with the use of these devices as well.

Discussion and Implications for Practice and Future Research

Implications for OT practice include the importance of patient positioning in the NICU. OTs can utilize the various positioning techniques outlined in this RSR to optimize development and growth in preterm infants.

Through these 30 studies, it is clear that various positioning strategies, techniques, and devices have the capability to significantly impact physiological, neurological, and developmental outcomes in preterm infants. A very large piece of the pediatric OT scope of practice is concerned with early intervention and approaching children and babies with a developmental frame of reference. Because positioning is an important segment of OT practice, the positive effects and outcomes of positioning interventions pose perfect justification for the value of occupational therapy in the NICU. It is paramount to recognize beneficial, non-invasive procedures that can be utilized in such an intense, stress-provoking environment.

Another major focus of OT related to developmental outcomes is the psychosocial component of overall health. The field of OT has built its foundation on holistic practice and entire-person approaches. While the mental health of infants is not easily measurable and therefore rarely considered, it can often be predicted based on relationships with caregivers. Although these babies are extremely young, their future quality of life and well-being can be forecasted by the quality of the attachment to their parents. Parental engagement, induced by skin-to-skin positioning methods, can improve positive physiological and autonomic responses to stress, and therefore facilitate organized behavior patterns that encourage positive developmental outcomes (Liaw, 2012). This skin-to-skin contact and healthy autonomic response also promotes the parent-infant relationship. The development of healthy attachment patterns and stress responses can predict better future mental health outcomes.

The majority of these modalities are only proven effective in preterm infants that are clinically stable and otherwise healthy. They should not be used in preterm infants with congenital deformities or other underlying health issues, nor should they be used in infants born at term, as the evidence does not support use in these populations. The role of OT in the NICU is to help the infants engage in “occupations” such as bonding with caregivers and interacting with their environment (Children’s Hospital of Philadelphia). OTs working in the NICU can use the information from this RSR to incorporate patient positioning into their interventions with preterm infants. There certainly is room for further research to be done especially in regards to babies born to term or babies with more serious health complications. While the evidence in this review yields great information for stable preterm babies, it is still important to explore the effects of these interventions on more diverse populations such as babies born to term, babies with serious medical complications, and any other infant health conditions that could benefit from non-invasive techniques.

Limitations

The current research provides limited high quality data/studies on preterm infants in the NICU. However, the data that was found support alternative positioning to improve growth and neurological development in preterm infants with the goal of reaching developmental milestones. The research found in these studies can be applied to NICU positioning but more research is needed to understand the full impact of these methods in clinical practice.

The results of this study are limited for many reasons. One major limitation is the exclusion of full term babies from each individual study, as well as the exclusion of preterm babies with severe medical complications. These studies exclusively examine one category of the infant population, and it is highly possible that these interventions can be effective elsewhere.

Another limitation of our study was the inability to include information from existing Level I studies such as other systematic reviews. These Level I studies contain valuable information that could have potentially provided great support for questions posed by our research.

Lastly, due to the limited amount of research available on this specific topic, we were forced to expand our search to a total of 12 countries including Australia & New Zealand, Canada, United Kingdom & Ireland, USA, Taiwan, Brazil, Netherlands, Norway, Iran, and France. This diverse source of data can potentially compromise results due to the cross-cultural variation of healthcare systems and the overall approach to medicine. Because all evidence was not extracted from a uniform healthcare delivery or research system, it can be tough to justify the generalizability of the results.

Conclusions

According to the results of the studies used within this systematic review, patient positioning is proven to be effective in improving physiological, developmental, and neurological factors in preterm infants in the NICU setting. The results of these thirty studies support the use of alternative patient positioning. The factors impacted by therapeutic positioning such as improved sleep-wake cycles, increased infant-caregiver bonding, and healthier vital signs all contribute to promote and or establish healthy growth and development patterns for preterm and low birthweight infants. Ultimately, further research is needed to gather more evidence to support this area of practice for occupational therapy.

References

American Occupational Therapy Association. (2008). Occupational therapy practice framework: Domain and process (2nd ed.). American Journal of Occupational Therapy, 62, 625–683.

Bastani, F., Rajai, N., Farsi, Z., & Als, H. (2017). The Effects of Kangaroo Care on the Sleep andWake States of PretermInfants. *The Journal of Nursing Research*, *25*(3), 231–239. doi:10.1097/jnr.0000000000000194

Casper, C., Sarapuk, I., & Pavlyshyn, H. (2018). Regular and prolonged skin-to-skin contact improves short-term outcomes for very preterm infants: A dose-dependent intervention. *Arch Pediatr, 25*(8), 469-475. doi:10.1016/j.arcped.2018.09.008

Comaru, T. & Miura, E. (2009). Postural support improves distress and pain during diaper change in preterm infants. *Journal of Perinatology, 29,* 504-507. https://doi.org/10.1038/jp.2009.13

Cong, X., Cusson, R. M., Walsh, S., Hussain, N., Ludington-Hoe, S. M., & Zhang, D. (2012). Effects of skin-to-skin contact on autonomic pain responses in preterm infants. *J Pain, 13*(7), 636-645. doi:10.1016/j.jpain.2012.02.008

Covidence [Computer program]. Version accessed 31 March 2020. Melbourne, Australia: Veritas Health Innovation. Available at covidence.org

Danner-Bowman, K., Cardin, A. (2015). Neuroprotective core measure 3: positioning & handling - a look at preventing positional plagiocephaly. *Newborn and Infant Nursing Reviews Journal,* 15, 109-111. doi: http://dx.doi.org/10.1053/j.nainr.2015.06.009

Diertens, D. M., & Wielenga, J. M. (2018). Developmentally accurate body posture of newborn infants: a quality assessment using the neoPAW score. *Infant*, *14*(1), 32–35.

Elsagh, A., Lotfi, R., Amiri, S., Gooya, H. (2019) Comparison of massage and prone position on heart rate and blood oxygen saturation level in preterm neonates hospitalized in neonatal intensive care unit: A randomized controlled trial. *Iranian J Nursing Midwifery Research* 2019;24:343-7

Gemin-Ribas, C., Andreazza, M., Neves, V., Valderramas, S. (2019). Effectiveness of hammock positioning in reducing pain and improving sleep-wakefulness state in preterm infants. Respiratory Care, 64(4), 384-388. doi: 10.4187/respcare.06265

Kahraman, A., Başbakkal, Z., Yalaz, M., & Sözmen, E. Y. (2018). The effect of nesting positions on pain, stress and comfort during heel lance in premature infants. *Pediatrics & Neonatology*, *59*(4), 352–359. doi: 10.1016/j.pedneo.2017.11.010

Khatony, A., Abdi, A., Karimi, B., Aghaei, A., & Brojeni, H. S. (2019). The effects of position on gastric residual volume of premature infants in NICU. *Italian Journal of Pediatrics, 45*(1), 6. doi:10.1186/s13052-018-0591-9

Knorr, A., Gauvreau, K., Porter, C. L., Serino, E., & DeGrazia, M. (2016). Use of the Cranial Cup to Correct Positional Head Shape Deformities in Hospitalized Premature Infants. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 45(4), 542-552. doi:10.1016/j.jogn.2016.03.141

Kristoffersen, L., Stoen, R., Hansen, L., Wilhelmsen, J., and Bergseng, H. (2016). Skin-to-skin care after birth for moderately preterm infants. Journal of Obstetric, Gynecologic, & Neonatal Nursing, 45, 339-345. doi: http://dx.doi.org/10.1016/j.jogn.2016.02.007

Lacina, L., Casper, T., Dixon, M., Harmeyer, J., Haberman, B., Alberts, J. R., Visscher, M. O. (2015). Behavioral observation differentiates the effects of an intervention to promote sleep in premature infants: a pilot study. *Adv Neonatal Care, 15*(1), 70-76. doi:10.1097/anc.0000000000000134

Liaw, J.J., Yang, L. Lee, C., Fan, H., Chang, Y., Cheng, L. (2013). Effects of combined use of non-nutritive sucking, oral sucrose, and facilitated tucking on infant behavioural status across heel-stick procedures: a prospective, randomized controlled trial. *International Journal of Nursing Studies, 50*(7), 883-894. https://doi.org/10.1016/j.ijnurstu.2012.08.021

Liaw, J. J., Yang, L., Hua, Y. M., Chang, P. W., Teng, C. C., & Li, C. C. (2012). Preterm infants' biobehavioral responses to caregiving and positioning over 24 hours in a neonatal unit in Taiwan. *Res Nurs Health, 35*(6), 634-646. doi:10.1002/nur.21499

Liaw, J. J., Yang, L., Lo, C., Yuh, Y. S., Fan, H. C., Chang, Y. C., & Chao, S. C. (2012). Caregiving and positioning effects on preterm infant states over 24 hours in a neonatal unit in Taiwan. *Res Nurs Health, 35*(2), 132-145. doi:10.1002/nur.21458

Ma, M., Noori, S., Maarek, J., Holschineider, D., Rubinstein, E., Seri, I. (2015). Prone positioning decreases cardiac output and increases systemic vascular resistance in neonates. *Journal of Perinatoloy* 35, 424–427

Madlinger-Lewis, L., Reynolds, L., Zarem, C., Crapnell, T., Inder, T., & Pineda, R. (2014). The effects of alternative positioning on preterm infants in the neonatal intensive care unit. *Research in Developmental Disabilities, 35*(2), 490-497. https://doi.org/10.1016/j.ridd.2013.11.019

Marulli, A., Kamlin, C., Dawson, J., Donath, S., Davis, P., Lorenz, L. (2017). The effect of skin-to-skin care on cerebral oxygenation during nasogastric feeding of preterm infants. Acta Paediatrica, 107, 430-435. doi: 10.1111/apa.14158

McCarty, D. B., O'Donnell, S., Goldstein, R. F., Smith, P. B., Fisher, K., & Malcolm, W. F. (2018). Use of a Midliner Positioning System for Prevention of Dolichocephaly in Preterm Infants. *Pediatr Phys Ther, 30*(2), 126-134. doi:10.1097/pep.0000000000000487

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses:* The PRISMA Statement

OCEBM Levels of Evidence Working Group (2011). *The Oxford Levels of Evidence 2.* Oxford Centre for Evidence-based Medicine.

Painter, L., Lewis, S., Hamilton, B. K., Dowling, D., & Thibeau, S. (2019). Improving Neurodevelopmental Outcomes in NICU Patients. *Advances in Neonatal Care (Lippincott Williams & Wilkins)*, *19*(3), 236–243. https://doi-org.proxy.ulib.uits.iu.edu/10.1097/ANC.0000000000000583

Park, J. , Thoyre, S. , Knafl, G. J. , Hodges, E. A. & Nix, W. B. (2014). Efficacy of Semielevated Side-Lying Positioning During Bottle-Feeding of Very Preterm Infants. The Journal of Perinatal & Neonatal Nursing, 28(1), 69–79. doi: 10.1097/JPN.0000000000000004.

Parsa, P., Karimi, S., Basiri, B., & Roshanaei, G. (2018). The effect of kangaroo mother care on physiological parameters of premature infants in Hamadan City, Iran. *Pan African Medical Journal*, *30*. doi: 10.11604/pamj.2018.30.89.14428

Positioning your premature baby. (2016). Retrieved April 14, 2020, from https://www.tommys.org/pregnancy-information/pregnancy-complications/premature-birth/your-babys-time-hospital/positioning-your-premature-baby.

Reynolds, L. C., Duncan, M. M., Smith, G. C., Mathur, A., Neil, J., Inder, T., Pineda, R. G. (2013). Parental presence and holding in the neonatal intensive care unit and associations with early neurobehavior. *Journal of Perinatology, 33*, 636-641. https://doi.org/10.1038/jp.2013.4

Santos, A. M. G., Viera, C. S., Toso, B. R. G. d. O., Barreto, G. M. S., & Souza, S. N. D. H. d. (2018). Clinical application of the standard operating procedure of positioning with premature Infants. *Revista Brasileira de Enfermagem*, 71, 1205-1211.

Stanford Children's Health. (2019). The Neonatal Intensive Care Unit (NICU). Retrieved November 15, 2019, from https://www.stanfordchildrens.org/en/topic/default?id=the-neonatal-intensive-care-unit-nicu-90-P02389.

Tully, K., Holditch-Davis, D., White-Traut, R., David, R., O'Shae, T., Geraldo, V. (2016). A test of kangaroo care on preterm infant breastfeeding. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 45*(1), 45-61. https://doi.org/10.1016/j.jogn.2015.10.004

Vittner, D., McGrath, J., Robinson, J., Lawhon, G., Cusson, R., Eisenfeld, L., . . . Cong, X. (2018). Increase in Oxytocin From Skin-to-Skin Contact Enhances Development of Parent-Infant Relationship. *Biol Res Nurs, 20*(1), 54-62. doi:10.1177/1099800417735633

Vittner, D., Butler, S., Smith, K., Makris, N., Brownell, E., Samra, H., & McGrath, J. (2019). Parent Engagement Correlates With Parent and Preterm Infant Oxytocin Release During Skin-to-Skin Contact. *Adv Neonatal Care, 19*(1), 73-79. doi:10.1097/anc.0000000000000558

Yin, T., Yuh, Y.-S., Liaw, J.-J., Chen, Y.-Y., & Wang, K.-W. K. (2016). Semi-Prone Position Can Influence Variability in Respiratory Rate of Premature Infants Using Nasal CPAP. *Journal of Pediatric Nursing*, *31*(2), e167–e174. https://doi-org.proxy.ulib.uits.iu.edu/10.1016/j.pedn.2015.10.014

Zimmerman, E., Barlow, S. (2016). The effects of vestibular stimulation rate and magnitude of acceleration on central pattern generation for chest wall kinematics in preterm infants. Journal of Perinatology, 32, 614–620. doi: 10.1038/jp.2011.177

Table 1. Evidence Table				
Author/Year	Level of Evidence/Study Design/Participation/ Inclusion Criteria	Intervention and Control Groups	Outcome Measures	Results
Bastani, F., Rajai, N., Farsi, Z., & Als, H. (2017)	Level 1 Randomized Control Trial N = 72 stable preterm infants in the NICU who all met the same inclusion criteria (gestational age > 32 weeks) Mean age: gestational age of 32-37 weeks Birth weight: greater than 1500 grams	Intervention groups were observed in a pre-intervention phase prior to the intervention phase. The intervention period lasted for 70 minutes where the infants were in the in-arms-holding group (cradled in their mothers' arms) and kangaroo care group (placed onto their mothers' bare chest). Final phase was the post-intervention where infants were placed in their incubators and placed in supine positions for 20 minutes.	Intervention phase: kangaroo care group (placed on mothers' bare chest) vs infants in the in-arms-holding group (cradled in their mothers' arms) Sleep and wake states were observed/recorded by observation during each phase.	No significant differences between the two groups in terms of state distribution in the pre-intervention phase. The Kangaroo care group had longer periods of deep sleep and quiet awake/alert state during the intervention phase. Less time was spent in the light sleep or drowsy state along with the actively awake state than in-arms-holding group. No differences were recorded in terms of crying.
Casper, Sarapuk, Pavlyshyn (2018)	Level III Study Design: Retrospective Study Participation: n=26, 18 male, 8 female Inclusion criteria: Gestational age less than 29 weeks, all had surfactant replacement therapy, none had congenital abnormalities, chromosomal diseases or congenital specific infections. Mean birth weight: 952.5 g Mean age: 27.27 weeks	Intervention groups were divided into 2 groups based on the initial SSC. Group 1- SSC was started in the first week, Group 2- SSC started after the 7th day. Depending on regularity of SSC two groups were formed A: SSC was performed everyday regularly, Group B: SSC was irregular (every 2 or 3 days), the groups were also divided on duration, group 1-SSC was performed over 3 hours per day, group 2-SSC was less than 3 hours.	The effects of SSC were measured by the duration, regularity and period of first contact between the infant and parent between the 2 assigned groups. The outcome was measured by the effect of SSC on secondary infections and breastfeeding/bonding.	Early SSC was found to have a lower incidence of secondary infections like bronchopulmonary dysplasia, nasocomial infection, and cholestasis. Regular SSC correlated with lower outcome of secondary infections. Lastly, longer duration of SSC was found to promote breastfeeding and reduce nasocomial infection.
Comaru, Miura (2009)	Level II Study Design: Randomized Crossover Clinical Trial Participation: n=47 Mean weight=1467+/-340g Mean age=32+/-2 weeks and 10 days of life Inclusion Criteria: Babies hospitalized in NICU of specific hospital with birth weight of ≤2000g and gestational age ≤35 wks	Infants in intervention group were placed in "nest" of rolled towel during diaper change for one day and not placed in "nest" the next day and repeated for 6 days	Heart rate, oxygen saturation, signs of distress (fingers splaying, salute, arch), facial expressions (eye bulge, face squeeze, naso-labial furrow, open lips, grimace, tongue protrusion, lip purse, chin quiver)	Distress and pain scores were significantly less when infants were nested. These results were statistically significant.
Cong et al. (2012)	Level I Randomized Control trial N = 26 50% male, 50% female M age = 30 weeks Intervention Group, n = 26 *Inclusion Criteria* 1) 28 0/7 to 32 6/7 weeks gestational age and less than 14 days old when recruited 2) Cared for in an incubator 3) Either NPO or on bolus feeds to control for feeding effects on HRV	Due to the nature of the crossover design of the study, both intervention groups received the same treatment—just in a variable order. Mother-infant dyads were randomly assigned to 1 of 3 sequences.	*Physiological* Heart Rate HRV Indices and autonomic responses using ANX3.0 Low Frequency areas (LFa) for sympathetic activity and High Frequency areas (HFa) for parasympathetic activity *Behavioral* Infant behavioral state was measured using Anderson Behavioral State Scoring System (1-12)	*Significant Findings* Infants HR changes were more in the IC condition than in both KC30 and KC15 at all stages (P<.05) In the IC condition, LFa values significantly changed through all phases (P<.05), while no significant changes in LFa across all KC conditions In the IC condition, HFa values significantly changed through all phases (P<.05), while no significant changes

	4) Mothers were >18 years old and English speaking			in HFa across all KC conditions Both KC30 and KC15 conditions infants spent more time in quiet sleep than in IC (P<.05) *Nonsignificant Findings* LF/HF ratio had no significant difference between the 4 phases among the 3 study conditions.
Danner-Bowman, Cardin (2015)	Level 4 Observational study N=103, 91 infants n=13, 20 Inclusion: NICU infants with scaphocephalic, brachycephalic, and plagiocephalic head shapes that had physical therapy orders	Intervention group 1: 2013 Intervention group 2: 2014 Repositioning of beds and infants in bed, caregivers instructed to provide care from each side of bed and increased tummy time	Head shape - intermittent cranial measurements using craniofacial calipers & passive neck range of motion assessment	Intervention groups showed a reduction in abnormal head shapes in the NICU upon 6-month post and one-year post return visit measurements.
Diertens, Wielenga (2018)	Level 4 One group, nonrandomized, observational N = 30 newborn NICU infants (gestational age > 26wks) with no neuromuscular diseases or treatments that affect positioning Median age: 30 weeks Median weight: 1,815g	The researchers took an observational approach, and did not personally manipulate variables. Instead, they observed to determine the quality of certain times.	The infants' positioning, respiratory support and swaddled status were recorded and rated using the Neonatal Postural Assessment Worksheet (neoPAW)	No infants scored below adequate, with the side lying position and older gestational age groups consistently presenting with higher scores. Authors do recommend further studies and training to aim for optimal positioning.
Elsagh A, Lotfi R, Amiri S, Gooya HH. (2019)	Level l Randomized Control Trial - 3 group clinical trial N = 75 stable preterm infants in the NICU who all met the same inclusion criteria (gestational age > 33 weeks) Mean age: gestational age (33-37 weeks)	The intervention groups consisted of groups of prone position, massage therapy as intervention groups, and the control group (no intervention). The intervention groups (prone position and massage) were administered for 5 straight days. Data/variables were recorded within each of the groups throughout the study.	Heart rate and blood oxygen saturation levels were recorded during each intervention or control group. The repeated measure ANOVA test was performed to evaluate and compare the effect of interventions.	The results indicated that massage and prone positioning equally led to the reduction of heart rate and increase in oxygen saturation levels compared to the control group.
Gemin-Ribas, Andreazza, Neves, Valderramas (2019)	Level 1 Randomized control clinical trial N= 26 infants n=13 intervention, 13 control 18 female, 8 males Age 32.7 weeks Inclusion: having a gestational age of between 30 and 37 weeks, breathing spontaneously, and being clinically stable	Intervention: hammock positioning for 2 hours/day 5 consecutive days Control: traditional positioning	Pain – Premature infant pain scale, Neonatal facial coding system scale Sleep wakefulness – Brazelton behavioral assessment scale Heart rate and SpO2 – pulse oximeter	Intervention groups showed a significant improvement in pain compared with traditional positioning group as well as higher sleep-wakefulness scores. It also helped to reduce heart rate and breathing frequency.
Kahraman, A., Başbakkal, Z., Yalaz, M., & Sözmen, E. Y. (2018).	Level l Randomized Control Trial N = 33 newborn NICU infants (gestational age > 31 weeks) that made it through the sampling process. Median weight: 1757g +/- 316 Median age: 33.03 +/- 1.31 weeks	The intervention groups were observed by two different researchers for the variables of infant responses to NIPS, COMFORTneo, COMFORTneo NRS-distress scores, COMFORTneo NRS-pain scores, and salivary. No variables were manipulated.	The infants NIPS, COMFORTneo, COMFORTneo NRS-distress scores, COMFORTneo NRS-pain scores, and salivary variables were recorded during the study.	The mean oxygen saturation level was significant;y increased during the prone positioning five minutes prior to the heel lance, 30 minutes prior to the heel lance and 30 minutes after the heel lance. Mean heart rate was higher in the prone position. Comparison of NIPS scores showed a significantly lower score in the prone position compared to the supine

				position. The COMFORTneo scores were significantly lower in the prone position compared to the supine position. The median salivary cortisol level during the prone positioning was lower than supine positioning 5-30 minutes prior to heel stance.
Khatomy, Abdi, Karimi, Aghael, & Brogeni (2019)	Level 1 Randomized cross over study N=135 58.5% male 41.5% female Inclusion: gestation age <37 weeks, mean apgar score at birth higher than a 6, heart rate, blood pressure, respiratory rate, O2 saturation stable, gavage feeding, and feeding mother milk. Exclusion: breast milk intolerance, development of intraventricular hemorrhage, necrotizing enterocolitis, congenital malformations, digestive problems, pneumothorax, convulsions, intolerance of feeding, unstable vital signs and need for mechanical ventilation.	The infants were divided into 3 groups of 45 to receive either prone, supine or right positions. Gastric residual volume was taken before and one hour after feeding to measure absorption of nutrients.	The outcome measured was the residual gastric volume in an infants stomach one hour after feeding based on prone, supine, and right-lateral positions. Was taken using a standard syringe (5cc SUPA co.). Data was collected and analyzed in the SPSS-21 using descriptive and analytical statistics (chi square, Kruskal Wallis, Shapiro test, and Freidman test.	There was no statistical difference between the groups, however the prone position had the lowest gastric residual volume, allowing for the most absorption. Authors concluded more research needed to be conducted.
Knorr, Gauvreau, Porter, Serino, & DeGrazia (2016)	Level 3 Prospective, descriptive pilot study N = 23 infants 61% male 39% female Inclusion: visible head deformity, less than or equal to 35 weeks gestation, weighed >1000g, received health clearance to participate	Intervention: Participants spent a minimum of 12 hours/day positioned on cranial cup, and received position changes every 3-4 hours while on device. All participants received the intervention.	Nurses kept daily logs of device use and position changes, and recorded number of cardiorespiratory/emesis events on and off device, ventilation, and CPAP use. Number of events, time spent on device, and final measurements were taken into account for final results.	Changes measured were significant, and 83% of participants presented with normal cranial measurements and no visible deformities at discharge.
Kristoffersen, Stoen, Hansen, Wilhelmsen, Bergseng (2016)	Level 2 Prospective cohort study N=90 infants n=47 intervention, 43 control 64 male, 26 female Age 32-34 weeks Inclusion: single and twin preterm infants born vaginally at 32 weeks/0 days to 34 weeks/6 days gestation in stable medical condition	Intervention: skin-to-skin contact between caregiver and infant Control: incubator placement	Oxygen saturation, HR and RR – Philips intellivue MP 30 neonatal Body temperature – rectally measured using Servoprax digitemp for skin-to-skin group, axillary measured using Terumo digital axillary C202 Blood glucose – Hemocue glucose 201, Accu-chek sensor	Intervention groups showed no significant difference in body temperature or blood glucose level, therefore supporting that skin-to-skin contact is safe for moderately preterm infants after vaginal birth.
Lacina, L., Casper, T., Dixon, M., Harmeyer, J., Haberman, B., Alberts, J., Simakajornboon, N., & Visscher, M. (2015).	Level I Randomized crossover study design N=25 premature infants in the Cincinnati NICU less than <37 weeks gestational age The medical status of each infant was evaluated using the Score for Neonatal Acute Physiology. 10 females, 15 males 31.5 +/- .6 weeks gestational age, 38.4 +/- .6 weeks adjusted age. 9 underwent surgery before and the range between surgery to the start of the study was between 7-79 days. 15 had general feeding difficulties, 10 were diagnosed with necrotizing enterocolitis and 3 were diagnosed with gastroschisis. All were receiving some type of oral feeding.	Control: Traditional positioning on a standard care mattress (SP). Allows infants more movement. Experimental: Conformational positioner mattress that conforms to the individual infants needs and provides barriers/containment. Adjustable to position requirement needs of each individual and maintains shape throughout; with no memory foam. Intervention: Pain assessments were performed before the study and during the study to ensure they were measuring arousal accurately. There were 2 nurses that implemented the interventions (standard mattress or conformational mattress) throughout both groups. The first nurse randomly assigned	Behavior was observed and polysomnography data was collected in order to compare results of qualitative and quantitative data to better support findings. The two developmental care nurses observed the behavior associated with sleep state by categorizing behavior present in self-regulatory, stress and sleep states (deep sleep, light sleep, drowsiness, quiet awake, active awake, and crying) throughout the designated 30 minute intervals. To justify observations made by nurses polysomnography data (left/right electrooculogram, 6 channel EEG, chin/intercostal EMG, EKG, oxygen saturation, pulse amplitude wave, and video monitoring) was collected throughout the 30 minute interval	With the conformational mattress intervention infants spent less time in awake states (alert, active awake and crying) through observation (F=8.4; P<.05). The time in sleep states (deep sleep and quiet sleep) were higher on the conformational mattress intervention but not statistically significant (F=3.4; P=.07). When looking at EEG, sleep efficiency and time in active sleep was higher for the conformational mattress vs. standard mattress (F=6.6 and 5.5; P<.05). Lastly, percentage time asleep was positively correlated with sleep efficiency (r=.78; P<.001).

		the first intervention; infants were transferred to the second intervention 5 hours later. During interventions the infants were observed for 30 minutes during each intervention; one in the early morning and one in the early evening. Different nurses assessed the same infant at different times. Polysomnography data was also collected during the 30 minute interval to compare findings found by the nurses. Data was collected and analyzed throughout the 30 minute interval and assessed by 2 polysomnographic technologists. The polysomnographic analyzed data in 30 second intervals.	and assessed by 2 polysomnographic technologists.	
Liaw et al. (2011)	Level III Prospective, descriptive study N=30 Participants did not differ significantly in sex, GA, PMA, days since birth or birth weight. All met the inclusion criteria of GA 27-37 weeks, PMA 27-37.5 weeks, pos birth age 3-28 days, disease condition acceptable for observation based on NTISS score of less than or equal to 21. 13.33% were born normal delivery and 86.67% were cesarean.	The intervention consisted of 30 infants who were recorded over 3 consecutive 24 hour periods. Sleep/wake states were observed from the 6 trained nurses, along with specific caregiving patterns, positions and NNS were measured. Sleep wake states were measured at 1 min intervals	Sleep/wake states: quiet sleep (QS), transition state (T), active awake (AW), Quiet Awake (QA) and fussing or crying (F) as defined by the study. NICU caregiving: no caregiving, social interaction, routine caregiving and intrusive caregiving, Positions: supine, lateral, prone, other NNS: sucking on or holding pacifier in their mouth All data was analyzed using SPSS	The study wanted to answer 3 main research questions of how different patterns of caregiving, positioning, and NNS effected sleep wake cycles. Outcomes include no caregiving, social interaction, lateral positioning and NNS use resulted in quiet sleep. routine and intrusive caregiving should be minimized to decrease crying and fussy states. Lastly, no caregiving, social interaction, lateral and prone positioning can facilitate AS.
Liaw et al. (2012)	Level III Nonrandomized Prospective Study N = 30 % male, % female M age = 31.59 gestational weeks Intervention Group, n = 30 *Inclusion Criteria* 1) GA 27-37 weeks 2) Postbirth age 3-28 days 3) Disease condition acceptable for observation	The intervention group consisted of 30 preterm infants whom all underwent the same patterns of caregiving and positions and outcome measures.	*Infant behaviors* Startle, jerk, or tremor; limb and trunk extension or squirming; finer or foot splay, fisting; grimace; hand to mouth, face, or head; sucking, sucking search, or mouthing; and hand holding or grasping *Physiological Parameters* HR, RR and O2 saturation *NICU Caregiving, Positioning, and NNS* Four patterns of caregiving (no caregiving, social interaction, routine caregiving, and intrusive caregiving) Four positions (supine, lateral, prone, other)	*Significant findings* With increasing care-giving induced stress (intrusive care-giving) and supine positioning, the occurrence of infant behaviors startle, jerk, or tremor; finger or foot splay or fisting; and grimace increased, consistent with reports that the more intrusive the caregiving, the more disorganized behavior that the infants showed. NNS and prone positioning decreased disorganized behavior. Social interaction, no caregiving, and routine caregiving increased rates of infant regulatory behaviors. *Nonsignificant Findings* The occurrence of limb and trunk extension or squirming was not significantly associated with the occurrences of no caregiving, intrusive caregiving, social interaction, routine caregiving, or any type of positioning. There were no significant physiological findings.

Liaw et al. (2013)	Level I RCT N=110 infants in Level III NICU Gestational ages 26.4-37 weeks Inclusion Criteria: premature infants receiving care in NICU	Intervention: Infants were assigned to 1 of 5 treatment conditions: sucking-oral sucrose-tucking, sucking-oral sucrose, oral sucrose-tucking, sucking-tucking Control group: routine care	Quiet sleep, active sleep, quiet awake, active awake, and fussing or crying recorded at baseline, intervention, heel-stick, and recovery	Infants in sucking-oral sucrose-tucking group experienced more quiet sleep and fewer occurrences of fussing or crying than other groups. These results are statistically significant.
Ma, M., Noori, S., Maarek, J. *et al.* (2015)	Level lll Prospective study N = 30 neonates who were admitted into the NICU. All infants met the inclusion criteria with a gestational age <35 weeks.	All infants were fitted with monitoring devices before data collection occurred. Data collection was first completed in the supine position then placed into a prone position for more data collection then the infants were placed back into the supine position for their final data collection. Each of these periods lasted 10 minutes.	Heart rate, stroke volume, and cardiac output were all monitored by electrical velocimetry for 10 minutes in supine, prone, and back-to-supine position. Skin blood flow was also assessed on the forehead.	Heart rate did not change in response to positioning during this study. Prone positioning indicated a decrease in stroke volume (SV), CO, and skin blood flow (SBF) levels and an increase in systemic vascular resistance (SVR) index.
Madlinger-Lewis et al. (2014)	Level I RCT N=100 premature infants born at ≤32 weeks gestation M age=28.7 weeks gestational age at birth Intervention group n=51 Inclusion Criteria: Admission into NICU, born ≤32 weeks gestational age	Intervention Group: infants placed in Dandle Roo positioning device when not being fed or undergoing medical procedure Control Group: any other positioning device, including swaddles, sleep sacks, and rolled towels	NICU Network Neurobehavioral Scale (NNNS) Neonatal Oral Motor Assessment Scale (NOMAS) Clinical Outcomes (days of ventilation, days of full oral feeds, length of stay)	Infants in the intervention group demonstrated less asymmetry during neurobehavioral testing. These results are statistically significant
Marulli et al. (2017)	Level 2 2 prospective crossover trials N=80 infants n=39 incubator fed, n=20 incubator and SSC fed 26 male, 33 female Age 26.1-30.1 weeks Inclusion: less than 33 weeks gestation, gavage pre-/during- and post-feed period was during either incubator period (control or postintervention), feeding was during SSC	Infants with feeds in incubator only and infants with feeds in incubator and during SSC	rStO2 – near-infrared sprectroscopy (continuous monitored) HR and SpO2 – pulse oximeter Hypoxic events - SpO2 < 80% for 5+ seconds Bradycardic events – HR < 100 beats per minute for 5+ seconds cFTOE – found by the following (SpO2 - rStO2)/SpO2 (20)	The two groups showed there was no difference in rStO2, HR, SD of rStO2, number of hypoxic and bradycardic events between feeding in the incubator and during SSC. The study overall shows that there is no change in rStO2 during SSC feeding supporting that gavage feeding during SSC is safe and has no effect on cerebral oxygenation.
McCarty et al. (2018)	Level III Nonrandomized Prospective Study N = 30 M age = 27 weeks GA Intervention Group, n = 30 *Inclusion Criteria* 1) Birth weight less than 1500g and GA less then 31 weeks at birth 2) less than 3 weeks chronological age at time of enrollment 3) stability on CPAP, nasal cannula, or room air	The intervention group of 30 preterm infants were compared to a retrospective study cohort (RSC) who received standard of care intervention as opposed to the Midliner Positioning System	*Cranial Molding Outcomes* Cranial Index measures	*Significant Findings* Infants who used the MPS had better cranial molding outcomes than infants who received standard-of-care intervention for cranial molding prevention.
Painter, Lewis, & Hamilton (2019)	Level 3 Quasi-experimental study N = 70 infants 60% female 40% male Intervention group n = 20 Inclusion: NICU patient; <34 wks GA; English-speaking family	Intervention: NICU staff were educated on use of positioning devices such as the Dandle Roo and blankets to support developmental positioning, as well as on the use of assessments for quality of positioning, and were instructed to implement both for study participants through discharge. Control:	The Infant Position Assessment Tool (IPAT) was used daily by NICU staff as a reference for optimal positioning, and OTs administered the Hammersmith Neonatal Neurological Examination just prior to discharge. Weight measurements were taken daily, and weight gain, length of stay, and demographic data were gathered at discharge.	No significant differences were seen in weight gain or length of stay, though a clinically significant increase was seen in flexion and tone with the use of the positioning intervention. A positive correlation was noted between the IPAT and Hammersmith scores.

		Usual care		
Park, Thoyre, Knafl, Hodges, & Nix (2013).	Level 2 Within subject crossover design, pilot study N=6 The infants were mostly similar at the start of the trial, most were female, half were white, all required certain types of respiratory support, infants had the same feeding skill and were able to consume 58.3% of their prescribed milk by mouth for a 72 hour period prior to the study. Infants differed in their PMA and feeding experience (breast or bottle). Inclusion criteria consisted of recruitment from level 3 NICU in North Carolina, gestational age less than 30 weeks, and absence of disorders that would affect feeding.	The trial investigated the effect of ESL compared to ESU positioning on ability to improve oral feeding in premature infants by supporting breathing. In order to measure the outcomes of positioning, heart rate, oxygen saturation, respiratory rate and feeding performance were assessed before and after feeding to compare effects. The design was a cross over experiment, each infant was fed twice over a 9 hour period on the same day with a random order of the ESL or ESU positions.	The outcomes of the effects of the two positions were measured by addressing physiological stability (HR, RR, oxygen saturation and feeding performance. Feeding performance was measured by assessing volume of milk consumed, HR was collected by 3 lead electrocardiograms every second, oxygen saturation was collected via Radial 7 Pulse Co-Oximeter every second, and RR by elastic band.	ESL had less variation in HR, higher breathing frequency, less variation in oxygen saturation and longer duration of feeding.
Parsa, P., Karimi, S., Basiri, B., & Roshanaei, G. (2018).	Level lll Quasi-experimental study N = 100 newborns admitted into the NICU who all met the inclusion/exclusion criteria. The gestational age ranged from 34-36 weeks of age.	The intervention group consisted of 50 preterm infants who were taken daily for kangaroo mother care (KMC) for an hour during 7 days. The control group consisted of the other 50 preterm infants who received their routine care performed in the incubator.	The study took place to evaluate the effect of Kangaroo Mother Care on physiological parameters consisting of heart rate, respiratory rate, arterial oxygen saturation, and body temperature in the premature infants.	After KMC there was significant change observed in heart rate levels of the intervention group while no significant change in the control group. Significant change was observed in respiratory rates of the intervention group while no significant change occurred in the control group. After KMC significant change was also observed in arterial blood oxygen saturation of the intervention group with no significant difference in the control group. The axillary temperature of the preterm infants in the intervention group showed significant change while no change was noted in the control group It is important to note that no significant differences in levels were shown between the two groups prior to the intervention.
Reynolds et al. (2013)	Level III Prospective cohort study N=81 preterm infants in NICU M age=26.6 weeks gestational age Inclusion Criteria: infants born at less than 30 weeks gestation	Intervention: nurses documented when parents held child (traditional holding) and received skin-to-skin holding (kangaroo care)	Modified Neonatal Infant Stressor Scale, NICU Network Neurobehavioral Assessment Scale,	Infants that experienced more skin-to-skin holding had less hypertonia. These results are statistically significant
Santos, Viera, Toso, Barreto, & Souza (2017)	Level 2 Quasi-Experimental Comparative Study N = 30 infants 60% male 40% female M age: 28-32 wks GA Intervention group: n = 24 Inclusion: Less than or equal to 32 wks GA, NICU patients, no known congenital or neurological abnormalities	Intervention: The intervention (implementation of Standard Operating Procedure of positioning, which utilizes Dorsal Decubitus, Ventral Decubitus, Right Lateral Decubitus, and Left Lateral Decubitus positions) was administered over a period of 5 days. HR, RR, SpO2, and pain level were recorded 30 min before an after positioning, in the 3 hours following the positioning, and 30 min before position change. Control:	The Neonatal Infant Pain Scale (NIPS) was used to evaluate pain levels. Data were analyzed using ANOVA, unpaired T-test, and Mann-Whitney tests.	Infants in the intervention group showed statistically significant decreases in pain and RR as compared to the control group.

		Usual positioning		
Tully et al. (2016)	Level I RCT N=231 preterm infants and their mothers Inclusion criteria: infants weighing less than 1750g but more than 1000g, no longer critically ill and can be held outside of incubator	Intervention: kangaroo care, auditory-tactile-visual-vestibular intervention Control: received preterm infant care nformation	Amount of breastfeeding during hospitalization, duration of postdischarge breastfeeding, and breastfeeding exclusivity after discharge	Breastfeeding did not differ statistically between treatment groups
Vittner et al. (2018)	Level I Randomized Control trial N = 28 68% male, 32% female M age = 33 weeks gestational age Intervention Group, n = 28 *Inclusion Criteria* 1. infants who were 30 0/7 – 34 6/7 weeks' gestational age, and between 3-10 days old at start of study 2) receiving either nothing per oral or on intermittent feeds to control for feeding effects on heart rate variability	Due to the nature of the crossover design of the study, both intervention groups received the same treatment—just in a variable order. The triads either had SSC with their mother first or their father first—having the alternative on the second day.	*Biobehavioral measures* Salivary oxytocin levels (parent and infant) Salivary cortisol levels (parent and infant) Parental Anxiety Levels Parent-Infant Interaction	*Significant Findings* Mother, father, and infant salivary oxytocin levels increased during skin-to-skin contact (SSC). Infant salivary cortisol levels were higher before and after SSC, as opposed to during. Maternal and paternal anxiety levels dropped during SSC. Both mothers and fathers were moderately responsive to the intervention. Parents and infants with higher oxytocin levels during SSC had significantly more synchronicity and responsiveness in their interactions *Nonsignificant Findings* No correlation between maternal or paternal cortisol levels and parent-infant interaction. No significant changes in parental salivary cortisol levels during SSC. No significant correlations between maternal and paternal anxiety levels and their respective salivary oxytocin or cortisol levels.
Vittner et al. (2018)	Level I Randomized Control trial N = 28 61% male, 39% female M age = 33 weeks gestational age Intervention Group, n = 28 *Inclusion Criteria* 1) infants who were 30 0/7 – 34 6/7 weeks' gestational age, and between 3-10 days old at start of study 2) otherwise healthy	Due to the nature of the crossover design of the study, both intervention groups received the same treatment—just in a variable order. The triads either had SSC with their mother first or their father first—having the alternative on the second day.	*Biobehavioral measures* Salivary oxytocin levels (parent and infant) Salivary cortisol levels (parent and infant) Parent engagement- PREEMI survey Parental Anxiety: Validated 8-item visual analog scale	*Significant findings* Oxytocin levels significantly increased and cortisol levels significantly decreased for mothers, fathers, and infants during SSC compared to baseline. Significant correlation infant oxytocin levels and maternal AND paternal engagement As maternal and paternal anxiety scores increased, their engagement scores decreased and vice versa. *Nonsignificant findings* No difference in oxytocin or cortisol levels whether infant was held by mother or father.

Yin, Yuh, Liaw, Chen, & Wang (2015)	Level 2 Repeated measures crossover design N = 47 45% male 55% female M gestational age (GA) = 28.6 wks Inclusion: GA 25-35 wks; <31 days old; no congenital, cardiopulmonary, metabolic, or infections diseases; birthweight < 2000g; being treated with 5cm H2O PEEP with room air	Intervention: Infants were placed in the three positions being studied in an assigned sequence over a 12hr period of time. Infants remained in each position for 60 min, and physiological parameters were measured and recorded 30 min after position changes, and every minute after that until the next position change. Due to crossover design, all participants received intervention.	The data were analyzed using SPSS 17.0, descriptive statistics included frequency, mean, percentage, and standard deviation, and generalized estimating equations were used HR, RR, and SPO2 in the different positions.	The only parameter which demonstrated significant change based on position was respiratory rate, which increased in the lateral position and stabilized in the semi-prone position.
Zimmerman, Barlow (2012)	Level 2 Quasi-randomized control trial N=27 infants 15 female, 12 male Inclusion: born between 28 and 34 weeks GA, currently receiving tube feedings, minimal or no oxygen history, head circumference within 10 to 90th percentile of mean for post- menstrual age, neurological examination showing no anomalies for PMA, stable vital signs (heart rate, blood pressure, age appropriate respiratory rate and baseline target oxygen saturation (SpO2) range appropriate for PMA to allow for stimulation) and at least 32 weeks PMA at the initiation of study	Intervention: VestibuGlide – 15 minutes gliding protocol (linear horizontal motion stimuli provided to infant), also given Soothie pacifier 3 times per day for 10 days Control: held for 15 minutes and offered Soothie pacifier as well 3 times per day for 10 days	Respiratory – chest wall kinematics measured by Respitrace Pulse/SpO2 – pulse oximeter Non-nutritive suck – Delrin receiver and waveforms, Honeywell pressure transducer Oral feed – daily oral feed percentage from nursing care	Vestibular stimulation given to preterm infants safely and effectively regulates respiratory rate and resets the respiratory central pattern generator.